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Project No.: 713

October 30, 2001

U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, D.C. 20555

Subject: Summary of Pre-application Presentations Regarding the Pebble Bed  
Modular Reactor (PBMR)

Dear Sir/Madam,

Attachment 1 is a summary of the PBMR design codes and standards information presented to the NRC staff on July 18, 2001. The summary compliments the slide presentation made to the NRC staff, and captures the presenter's discussion and responses to questions raised during the presentation. Exelon Generation (Exelon) requests the NRC review the information, assess it for appropriateness and completeness in regard to the type and scope of acceptable standards sufficient to support a Combined License Application within each indicated discipline area, and provide feedback including any assumptions used by the NRC staff.

Attachment 2 is a data table that provides additional information pertaining to the analytical computer codes that are currently being used by PBMR Pty. designers. The table compliments the information presented to the NRC Staff on August 16, 2001. Exelon requests that the NRC assess the information and provide their familiarity with the codes and identify any NRC code related long-lead actions necessary to prepare for receipt and review of a Combined License Application. Exelon also requests that the NRC provide early feedback regarding any known weaknesses or concerns about the analytical codes and methods that should be addressed in the application.

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Response to the above requests during the pre-application period will allow Exelon Generation the ability to assess the US licensability of the PBMR design, and provide for a complete Combined License Application.

If you have any questions, please contact me at (610) 765-5528.

Sincerely,

A handwritten signature in black ink, appearing to read "Kevin F. Borton", with a stylized flourish extending from the end.

Kevin F. Borton  
Manager, Licensing

Attachments

cc: Thomas King, RES  
William Borchardt, Associate Director NRR  
James Lyons, NRR  
John Flack, RES  
Stuart Rubin, RES  
Amy Cubbage, NRR

**Attachment 1**

Exelon Generation  
Letter Dated October 30, 2001

"Summary of PBMR Design Codes and Standards"  
Presented to the US NRC on July 18, 2001

5 pages

## **Summary of PBMR Design Codes and Standards Presentation to US NRC on July 18, 2001**

### **Presentation Purpose:**

This presentation provided the NRC staff with an understanding of the Design Codes and Standards and other Regulatory/Industry guidance being used (or being considered for use) in the design of the PBMR. It was requested that the NRC staff review this information and assess it for appropriateness and completeness within each identified discipline area below and provide feedback including any assumptions used by the NRC in their review. It was also requested that the NRC staff review any cited Codes or Standards with which they are unfamiliar and determine what action is necessary in regard to a PBMR Combined License application / NRC review.

Two specific American Society of Mechanical Engineers (ASME) approved code cases are noted as requiring NRC approval for use.

*The NRC staff raised several questions during the meeting. The questions asked and Exelon's responses are recorded below under each appropriate section and are in italics. Discipline experts from PBMR Pty., South Africa were available via telephone link to respond to some of the design specific questions.*

### **Presentation Introduction & Overview**

The presentation began with a brief overview of the Integrated Design Process as it includes the selection and application of Codes and Standards as part of the PBMR Pty. "Design Rules." Codes and Standards related to specific "disciplines" were then discussed.

The PBMR Integrated Design Process Codes and Standards selection philosophy encourages the use of established, internationally recognized design and construction rules whose applicability is demonstrated and compatible with the PBMR design and safety requirements. Where differing requirements are encountered, the more conservative requirement will be followed.

The following summarizes the specific discipline area discussions.

### **Civil, Structural and Seismic –**

The primary civil code being used is American Concrete Institute ACI 349-90, "Code Requirements for Nuclear Safety Related Concrete Structures." Subsidiary codes are also used for reference.

The primary structural code used is American National Standards and Institute / American Institute of Steel Construction ANSI/AISC N690-1994, "American National Standard Specification for the Design, and Fabrication and Erection of Steel Safety-Related structures for Nuclear Facilities."

For steel supports, ASME Code Section III, 1998, "Boiler and Pressure Vessel Code, Div 1, Subsection NF, Supports" is used.

For determining design envelope loading the following codes are used;

- ASCE 7-8, "Minimum Design Loads for Buildings and Other Structures"
- US DOE STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities"
- SABS 0160-1989, "South African Standard, Code of Practice; General Procedures and Loads to be adopted in the design of Buildings"

Seismic design guidance will include US NRC guidance (including NUREG 0800, Regulatory Guides 1.122, 1.165, 1.60, and others), US DOE guidance (including DOE STD 1020-94), and IAEA guidance (including 50-SG-S2). Some of these documents also provide design guidance for tornado and other natural hazards as well as protection from missiles, aircraft crashes, etc.

*Question: To the extent that they are not already reflected in ANSI/AISC N690-1994, whether NRC Branch Technical Positions (BTP's) on early versions of this standard apply?*

*Response: The PBMR design team has not identified any of the BTP's that apply to ANSI/AISC N690-1994 in the public domain. The team would appreciate if the staff would indicate any specific documents that they believe need to be reviewed, and indication whether they are electronically available to the South African designers.*

#### **RPV, Primary Pressure Boundary –**

The RPV will be designed and fabricated in accordance with ASME Section III, Division 1, Subsection NB - Class 1 Components, 1998. ASME approved Code Case N-499 (1994), which permits temperatures up to 538 deg. C, (limited to specified pressures and durations) is used to address the higher temperatures experienced during a Pressurized Loss of Forced Coolant (PLOFC) event (420 deg. C) and a Depressurized Loss of Forced Coolant (DLOFC) event (480 deg. C).

NRC approval of this code case is needed.

The RPV Internal Core Barrel will be designed and fabricated in accordance with ASME Section III, Division 1, Subsection NG – Core Support Structures, 1998. ASME approved Code Case N-201 (1994), which permits temperatures up to 816 deg. C, (limited to specified pressures and durations) is used to address the higher temperatures experienced during a PLOFC event and a DLOFC event (720 deg. C).

NRC approval of this code case is needed.

The Primary Pressure Boundary will be designed and fabricated in accordance with ASME Section III, Division 1, Subsection NC – Class 2 Components, 1998. ASME Section XI guidance will be used in developing the Inservice Inspection (ISI) program. Inspectability is one of the design considerations.

*Question 1: Inform NRC of whether PBMR plans to perform continuous monitoring of the materials in the primary pressure boundary?*

*Response: ASME Section XI will be used for guidance. This code, 1998 version refers to a 1992 version for guidance on in-service inspection considerations for High Temperature Gas Reactor designs. The 1992 document briefly discusses ASME's future plans for developing such code guidance. ASME has not issued this to date. The six year outage cycle, accessibility to certain welds in the primary pressure boundary during operation and the different failure mechanisms from what are experienced in LWR's may require the approval of some exemptions from the standard Section XI requirements. These requirements were developed for LWR designs with operating cycle duration of two years or less.*

*Question 2: Exelon will inform the NRC of whether (and when) NRC should review previously approved codes and standards for LWR's to determine whether they are acceptable to apply to the PBMR (i.e., should the NRC review LWR codes and standards regarding environmental fatigue to determine whether NRC will apply them to the PBMR?).*

*Response: This request is considered to be an application phase activity and will be communicated to the NRC staff at the appropriate time.*

*Question 3: As part of it's discussion on safety classification, Exelon will explain why the primary pressure boundary (except for the Reactor Pressure Vessel) is ASME Class 2 rather than Class 1?*

*Response: This item will be discussed at a future meeting on safety classification following further progression of the design. For NRC staff's consideration, it is noted here that the Reactor Pressure Vessel (RPV) and the rest of the Primary Pressure Boundary (PPB) from a Safety Analysis perspective*

*are more leak tolerant than the LWR designs. It is judged at this time in the design process that Class 2 is sufficient and provides adequate margin. However, the RPV has an additional function to maintain core geometry. It was therefore classified as Class 1. Structures, Systems, and Component classification will continue to be assessed as the design progresses.*

*Question 4: What are the materials specified for the Reactor Pressure Vessel and the Primary Pressure Boundary?*

*Response: The Reactor Pressure Vessel material of construction selected is SA 508 C13. This is a 2.25 Cr, 1 Mo Steel with wide experience base in PWR's. (C-Mn-Ni Steel). The remaining Primary Pressure Boundary (i.e., Power Conversion Unit) material of construction selected is SA 533 B.*

### **Electrical and Instrumentation & Control –**

The primary standards for the nuclear safety-related systems, such as Reactor Protection System (RPS), Post-Event Instrumentation (PEI), associated neutronic instrumentation, and RPS & PEI Human Machine Interfaces (HMI), are Institute of Electrical and Electronics Engineers, IEEE Standard (Std) 603, 1998 and IEEE Std 7-4.3.2, 1993. Other applicable IEEE sub-references used are, IEEE Std 308, IEEE Std 344, IEEE Std 577 and IEEE 1023 for RPS/PEI HMI only. Guidance from NUREG 0800 will also be used. It is noted that 10CFR50.55a refers to IEEE 603, 1991 edition; the PBMR project is working to the 1998 edition. This will need to be addressed with the NRC.

Non-nuclear safety-related systems for equipment protection will be designed in accordance with ANSI/ISA S84.01, 1996. Non-nuclear safety-related systems for operational control will be designed in accordance with International Electrotechnical Commission (IEC) standards. The International Electrotechnical Commission, based in Geneva, Switzerland, is affiliated with the International Organization for Standardization – ISO, and is endorsed by 14 countries, including the US, UK and Germany.

NUREG 0700, "Human System Interface Review Guidelines" is the primary input to Control Room design (excluding RPS & PEI HMI). Other applicable references include NUREG 0711, NUREG CR 5908, NUREG CR 6105, and NUREG CR 6146 and other relevant NRC issued CR's. Guidance from NUREG 0800, Chapters 13 and 18, will also be used. It was noted that the Control Room design is in a preliminary stage at this time.

Guidance from NUREG 0737 and other appropriate guidance will be used for the radiological monitoring system, seismic monitoring system, etc., which are in the preliminary design stage.

IEC Standards will be used in the design of the 50 Hz electrical power systems.  
IEEE Standards will be used in the design of the 60 Hz electrical power systems.

*Question 1: What International Electrotechnical Commission (IEC) standards apply?*

*Response: IEC 61131-3 is used for the Controller software in the Operational Control System (non-nuclear safety related) design. Other standards that will be used as the design progresses will be identified. Other IEC standards will apply to the 50-cycle version for non-US markets but will use IEEE guidance for the 60-cycle machines intended for the U.S.*

*Question 2: Do IEEE 384, IEEE 308 and NUREG-0800 Chapter 8 apply?*

*Response: IEEE 384, 1992, does apply to the Reactor Protection and Post Event Instrumentation Systems. IEEE 308 does not apply directly but is used as a reference. NUREG 0800, Chapter 8, will be reviewed for applicability.*

*Question 3: Which version of IEEE-304 will be applied?*

*Response: This standard applies to the evaluation of insulation on Direct Current machines and does not apply to the PBMR design.*

## **Fire Protection –**

Fire protection related design is in the preliminary stage. Guidance from National Fire Protection Agency (NFPA) (e.g. NFPA 80, NFPA 101, & Life Safety), NUREG 0800, Section 9.5.1, "Fire Protection Program", and the International Atomic Energy Agency-IAEA Safety Standard Series (i.e., NSG 2.1) is being considered. Guidance from other appropriate NRC documents (SECY's, RG's, etc.) will also be used.

*NRC staff noted that RG 1.189, 'Fire Protection for Operating Nuclear Power Plants' would provide some useful guidance for the designers. It was noted that NFPA 805 is for existing LWRs and would not be applicable to the PBMR design.*



**Attachment 2**

Exelon Generation  
Letter Dated October 30, 2001

"PBMR Analytical (computer) Codes Data Table"  
Presented to the US NRC on August 16, 2001

5 pages

PBMR Analytical (Computer) Codes  
Data Table  
Engineering Analysis

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
1	Flownet	South Africa	M-Tech Pty. Ltd. Potchefstroom SA <a href="http://www.flownet.net">www.flownet.net</a> 27-181-299-4023 <a href="mailto:Dinjvr@puknet.puk.ac.za">Dinjvr@puknet.puk.ac.za</a>	Yes	May be negotiable with supplier	Yes	Vendor may be interested in submitting topical
A	Flownet Designer	South Africa	M-Tech Pty. Ltd. Potchefstroom SA <a href="http://www.flownet.net">www.flownet.net</a> 27-181-299-4023 <a href="mailto:Dinjvr@puknet.puk.ac.za">Dinjvr@puknet.puk.ac.za</a>	Yes	May be negotiable with supplier	NA	Vendor may be interested in submitting topical
B	Flownet Nuclear	South Africa	M-Tech Pty. Ltd. Potchefstroom SA <a href="http://www.flownet.net">www.flownet.net</a> 27-181-299-4023 <a href="mailto:Dinjvr@puknet.puk.ac.za">Dinjvr@puknet.puk.ac.za</a>	Yes	May be negotiable with supplier	NA	Vendor may be interested in submitting topical
2	Fuelnet	South Africa	PBMR <a href="mailto:Mark.mitchell@pbmr.co.za">Mark.mitchell@pbmr.co.za</a> 27-12-677-9400 Ext. 9575	Yes	May be negotiable with supplier	NA	Vendor may be interested in submitting topical
3	Star-CD	UK	Computational Dynamics, Ltd. <a href="http://www.cd.co.jk">www.cd.co.jk</a> 44-81-969-9639	Yes	No	Yes	
4	Fluent	USA	Fluent USA, Inc. <a href="http://www.fluent.com">www.fluent.com</a> (603) 643-2600	Yes	No	Yes	
5	PFC 3D	USA	Itasca Consulting, Inc. <a href="http://www.itascaeng.com">www.itascaeng.com</a> (612) 371-4711	Yes	No	TBD	
6	Patran	USA	MSC Software <a href="http://www.mscsoftware.com">www.mscsoftware.com</a> (714) 540-8900	Yes	No	NA	
7	Nastran	USA	MSC Software <a href="http://www.mscsoftware.com">www.mscsoftware.com</a> (714) 540-8900	Yes	No	Yes	
8	ADAMS	USA	MSC Software <a href="http://www.mscsoftware.com">www.mscsoftware.com</a> (714) 540-8900	Yes	No	NA	

PBMR Analytical (Computer) Codes  
Data Table  
Reactor Analysis

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
1	VSOP	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	VSOP 94 Version
A	VSOP	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
B	Zut	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
C	Data2	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
D	Birgit	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
E	Firzit	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
F	Trigit	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	
G	Life	Germany	Julich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes	May be negotiable with supplier	Yes	

PBMR Analytical (Computer) Codes  
Data Table  
Reactor Analysis  
(Cont'd)

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
2	TINTE	Germany	Jullich NEA Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33-145-24-1110	Yes		Yes	
3	RZ-KIND	Germany	University of Stuttgart Dr. Gunter Lohnert <a href="mailto:lohnert@ike.uni-stuttgart.de">lohnert@ike.uni-stuttgart.de</a>	Yes		TBD	
4	ZIRKUS	Germany	University of Stuttgart Dr. Gunter Lohnert <a href="mailto:lohnert@ike.uni-stuttgart.de">lohnert@ike.uni-stuttgart.de</a>	Yes		TBD	
5	DIRECT	Germany	University of Stuttgart Dr. Gunter Lohnert <a href="mailto:lohnert@ike.uni-stuttgart.de">lohnert@ike.uni-stuttgart.de</a>	Yes		TBD	

PBMR Analytical (Computer) Codes  
Data Table  
Radiation Analysis

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
1	MCNP	USA	Los Alamos NL New Mexico	Yes	Maybe negotiable with supplier	Yes	
2	SCALE4.4	USA	Oak Ridge NL Tennessee	Yes	Maybe negotiable with supplier	Yes	
A	ORIGEN	USA	Oak Ridge NL Tennessee	Yes	Maybe negotiable with supplier	Yes	
3	FISPACT/ EASY97	UK	NEA, Data Bank, Paris <a href="http://www.nea.fr">www.nea.fr</a> 33 145 24 1110	Yes	Maybe negotiable with supplier	Yes	
4	SPATRA	Germany	Jullich <a href="http://www.fz-juelich.de">www.fz-juelich.de</a>	Yes	Maybe negotiable with supplier	Yes	
5	ORIGEN- JUEL-II	Germany	Jullich <a href="http://www.fz-juelich.de">www.fz-juelich.de</a>	Yes	Maybe negotiable with supplier	TBD	
6	MCBEND	UK	AEA Technologies <a href="http://www.aeat.co.uk">www.aeat.co.uk</a> 44-1235 433 612	Yes	No	TBD	
7	RADAX	Germany	Westinghouse Reaktor/BNFL <a href="http://www.westinghouse.com">www.westinghouse.com</a>	Yes	Maybe negotiable with supplier	TBD	

PBMR Analytical (Computer) Codes  
Data Table  
Fuel Design & Performance Analysis

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
1	PANAMA	Germany	Jullich <a href="http://www.fz-juelich.de">www.fz-juelich.de</a>	Yes	Maybe negotiable with supplier	Yes	
2	FRESCO	Germany	Jullich <a href="http://www.fz-juelich.de">www.fz-juelich.de</a>	Yes	Maybe negotiable with supplier	Yes	
3	STRESS	UK	AEA Technologies <a href="http://www.aeat.co.uk">www.aeat.co.uk</a>	Yes	Maybe negotiable with supplier	Yes	
4	STAPLE	UK	AEA Technologies <a href="http://www.aeat.co.uk">www.aeat.co.uk</a>	Yes	Maybe negotiable with supplier	Yes	
5	NOBLEG	Germany	Westinghouse Reaktor/BNFL <a href="http://www.westinghouse.com">www.westinghouse.com</a>	Yes	Maybe negotiable with supplier	TBD	
6	GETTER	Germany	Westinghouse Reaktor/BNFL <a href="http://www.westinghouse.com">www.westinghouse.com</a>	Yes	Maybe negotiable with supplier	TBD	

PBMR Analytical (Computer) Codes  
Data Table  
Risk & Consequence Analysis

Item	Code Name	Country of Origin	Developer/Owner Contact Information	Commercial/Availability Status		PBMR V&V Plan	Notes/Comments/Miscellaneous
				Commercial/Object Code Available?	Source Code Available?		
1	RISK SPECTRUM	Sweden	Relcon <a href="http://www.riskspectrum.com">www.riskspectrum.com</a>	Yes	No	Yes	
2	PC COSYMA	UK	NRPB <a href="http://www.nrpb.org.uk">www.nrpb.org.uk</a>	Yes	No	Yes	
3	LUDEP	UK	NRPB <a href="http://www.nrpb.org.uk">www.nrpb.org.uk</a>	Yes	No	Yes	